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(54) Bottle for controllably dispensing a liquid by drops.

(57) A bottle (10) for controllably dispensing liquid contents (18) as drops (20) deliverable within a predetermined size range has a delivery tip portion (14) formed internally as an elongated frustro-conical outwardly opening passage (26) having a wide end for forming individual liquid drops (20) thereat and, at a narrow end, an insert element (32) with an internal bore (34) of selected diameter (x) and length (L) for thereby regulating the rate of flow of liquid contents (18) from the bottle (10) to the bottle tip (14). In another aspect of the invention, an annular recess (30,D,d) is formed, of somewhat larger transverse cross-sectional area than the wide end of the liquid delivery passage (26) and at its very end, to form and hold individual drops that are selectively releasable to be within a preselected size range.

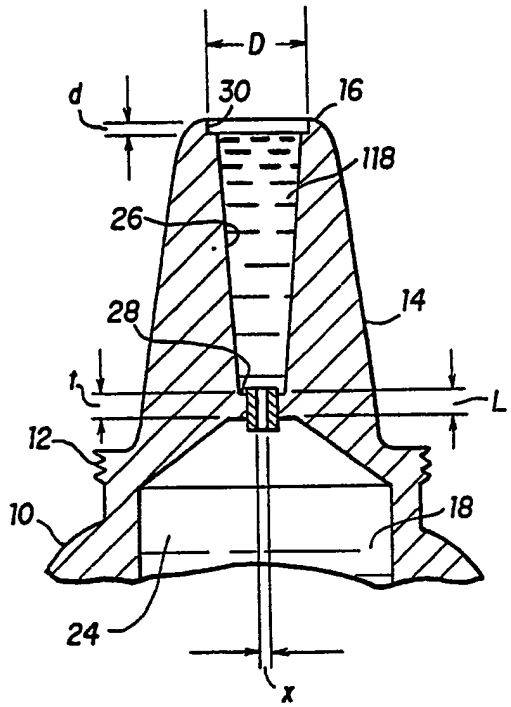

FIG. 2

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BOTTLE FOR CONTROLLABLY DISPENSING A LIQUID BY DROPS

Technical Field

This invention relates to a bottle for dispensing liquid contents by individual drops and, more particularly, to a bottle having a dispensing tip portion formed to include an insert having a bore of predetermined cross sectional area and length to regulate the flow to generate liquid drops within a predetermined size range.

Background of the Invention

There are numerous situations in which a liquid material is most advantageously dispensed in the form of drops, preferably drops that are predictably within a predetermined size range. Such applications include the provision of medications such as eye drops to patients' eyes, in the dispensation of which an overdose of medication must be avoided. Usually, in such circumstances, the bottle containing liquid contents is uncapped, typically by the detachment of a screw-on cap, whereafter the user gently squeezes the bottle to dispense from a distal tip end thereof one or more drops of medication intended to be deposited at a selected location, e.g., an eye. Such bottles, typically, are made of a flexible plastic material and the tip generally has an outer conical elongate shape with an aperture at which individual drops are formed before they separate from the bottle for deposition at the intended site.

Unless relatively fine control is exercised over the flow of the liquid contents from the bottle into the tip end for formation of drops falling therefrom, there is always the danger of either a forcible squirting of liquid contents or the formation of a rapidly falling stream of drops that could result in an undesirable overdose. It has long been known that the provision of a constricted opening or passage that limits the rate at which liquid contents flow out of the bottle is beneficial. The practical problem in effecting this known solution relates to economically viable methods of manufacturing the tip portions of bottles that conveniently contain such contents.

Most plastics materials that are safe and convenient for use of the type at issue are thermoplastics and, when the tip ends of such bottles are molded, the provision of the fine orifice through which the liquid contents must flow to the tip end of the bottle requires the disposition of a core of very small diameter. The core must be subsequently removed without damaging the resulting molded part. For applications such as the provision of eye drops, such orific s must have diameters in the range 130-150 microns and numerous attempts have been made utilizing metal wires of this diameter as cores to generate such orifices. Unfortunately, because of high molding temperatures and the forces with which the material and various elements have to be manipulated, too often the core wire tends to break and remains within the orifice from which it must be extracted. As a consequence, serious quality control problems are presented to the manufacturer, not the least of which is to inspect each such tip to insure that the core wire has been effectively removed without damaging the remaining tip.

Solutions to this problem have been sought in various countries, and examples include U.S. Patent No. 3,276,639, to Lancaster, which addressed the problem of producing a series of drops each having a volume of 0.05 milliliters with an accuracy of plus or minus 2 1/2% in such a manner that the accuracy of the dropper would be 40 drops plus or minus one drop per one milliliter of liquid. The Lancaster device utilized a fine bore tube leading to an expanding conical portion at the very end. Another example of this art is U.S. Patent No. 3,276,847, to Duff et al, which teaches a tubular dropper for microtitration that also includes a long tubular element with an expanding conical end. Examples from other countries include, for example, Swiss Patent No. 474,412, in which a bottle has a tip that opens conically outward and allows flow of fluid through a small orifice at the bottom of a frustro-conical section and French Patent No. 821.258, to Regard, teaches a fine bore tubular section with a relatively wide open conical end. As noted earlier, the major problem in the manufacture of such devices is the location of the core wire during molding of the bottle tip, insuring that it does not break, and guaranteeing that the aperture left thereafter is capable of performing the desired function.

There exists, therefore, a need for a solution that assures a manufacturer of a bottle for dispensing liquid contents by drops that the flow of liquid to a tip designed to release drops within a certain size range will be regulated effectively and can be manufactured with consistent quality control so that there is relatively small danger of generating too many drops or drops of too large a size.

Disclosure of the Invention.

Accordingly, it is an object of this invention to provide a bottle for controllably dispensing liquid

contents therefrom as drops that ar d livered within a predetermined size range.

Another object of this invention is to provide a bottle having a delivery tip portion that is easily manufactured of plastics material and ensures regulation of the flow of liquid contents from the bottle to be released as drops delivered within a predetermined size range.

It is a further object of this invention to provide a delivery tip element suitable for use with a bottle (or other container by a liquid) that, with the selection of an insert element, can be readily manufactured to suit a range of needs that include the provision of drops of liquid contents from a varieity of compatible bottles in drops within any of plurality of size ranges.

It is a related further object of this invention to provide an insert element having an internal bore of a predetermined cross-sectional area and length to ensure selective regulation of the flow rate of liquid contents from a bottle therethrough, to facilitate the dispensation of such liquid contents as individual drops within a predetermined size range.

These and other related objects of this invention are realized by providing a bottle for controllably dispensing liquid contents therefrom as drops that are delivered within a predetermined size range, in which a delivery tip portion is formed internally as an elongate frustro-conical outwardly opening passage having a wide end for forming individual liquid drops thereat and a narrow end for receiving a regulated flow of liquid from the bottle contents, and a liquid flow regulating insert element having an internal bore of predetermined cross sectional area and length, the insert element being located at a narrow end of the tip portion to regulate flow of the liquid from the bottle into the tip portion. In another aspect of this invention there is provided an annular recess of predetermined depth and a larger transverse cross sectional area than the wide end of frustro-conical passage communicating therewith, whereby individual liquid drops form at the recess for controllable separation therefrom when within a predetermined size range.

Still other objects and advantages of the present invention will become readily apparent to those skilled in the art from the following detailed description, wherein only the preferred embodiments of the invention are shown and described, simply by way of illustration of the best modes contemplated for carrying out the invention. As will be realized, the invention is capable of other and different embodiments, and its several details are capable of modifications in various obvious respects all without departing from the invention. Accordingly, the drawing and description hereof are to be regarded as illustrative in nature, and not as restricted, the invention being d fined solely by the claims appended hereto.

Description of the Drawings

Figure 1 is a vertical cross-sectional view along an axial plane of a bottle according to this invention, the same being held in a position convenient for delivering liquid contents by drops therethrough.

Figure 2 is a vertical cross-sectional view along an axial plane of a bottle according to a preferred embodiment of this invention following at least one use thereof to deliver liquid by drops.

Description of the Preferred Embodiments

A bottle 10, formed according to a preferred embodiment of this invention has toward an open end thereof a shoulder portion 12, which may be externally threaded for receiving a closure cap (not shown) when the bottle is not in use so as to protect liquid contents of the bottle from contamination by ambient dirt, bacteria and the like.

The delivery end of such a bottle 10 may conveniently be formed as an elongate portion 14 having an end 16 from which liquid contents 18 of the bottle may be expelled in the form of drops 20 that each form a neck 22 immediately prior to separation from the bottle. Such bottles, considering cost, manufacturing convenience, amenability to sterilization so as to contain sensitive medications, flexibility for convenience of transportation, handling, and use, inter alia, are usually made of flexible plastics materials. As a practical matter, manufacture of such bottles, especially the tip end portions thereof, involves various aspects of the molding of thermoplastics material.

Reference may now be made to Figure 2, which is a vertical cross-sectional view along an axial plane of a typical bottle according to preferred embodiment of this invention. Below a tip end portion of a bottle 10, there is seen an upper portion 24 of the internal volume of bottle 10 that contains, most likely, some air over an upper surface of liquid contents 18. With the bottle vertical, i.e., with its tip uppermost, a small amount 118 of the liquid contents of the bottle that have been expelled towards the tip end 16 may be expected to remain within an elongate frustro-conical tapered base defined by a wall 26 and ending in a base 28 if the bottle has been used at least once. The wider end of the frustro-conical surface 26 is towards the outermost portion of the tip end of the bottle, i.e., the nd adjacent the end surface 16 thereof.

According to one aspect of this invention, in order to assist the formation of drops of predetermined size and their convenient collective succes-

sive release by individual drops thereafter, an annular recess defined by an outer cylindrical surface 30 of a diameter "D" and a depth "d" may be formed as illustrated in Figure 2. An opening, not numbered in order to avoid confusion, is formed in the base 28 of a diameter sufficient to receive tightly therewithin an insert element 32 to be described more fully hereinafter.

As persons skilled in the art will appreciate, if a fine bore aperture is to be formed in the base of the frustro-conical portion defined by surface 26, a very small diameter (e.g., 130-150 microns) core wire would have to be positioned accurately and removed intact thereafter to leave behind a fine bore aperture. Experience has shown that such fine bore wire, because of the physical manipulation of the wire and pressure involved in the step of forming the thermoplastics material, occasionally breaks and remains within the aperture that was to be formed when the bottle tip portion is removed from the mold. When one of the molding apparatuses is so damaged, i.e., when the orifice generating wire has broken off and is no longer available to form orifices in successive bottle tips molded thereby, a number of orificeless bottle tips may be manufactured and must be detected and rejected. This necessitates extremely precise quality control because, otherwise, either the bottle cannot be filled with liquid or, if filled, cannot deliver any liquid. Also, breakage of such core wires imposes extra stress on those maintaining and servicing the molding equipment. All of this adds up to additional cost and serious quality control problems.

In the improvement to the art offered by the present invention, there is provided a preformed insert element 32 of a material compatible for molding into place into base 28 such that it has an internal bore diameter "x" and a total bore length "L" carefully selected in light of the liquid to be dispensed therethrough so as to exercise effective regulation of the flow rate of the liquid when a user elects to dispense the same. The outer surface of insert element 32, as will be understood by persons skilled in the art, may be made rough or otherwise amenable to sealing/bonding with the bottle material being molded therearound. Although Figure 2 illustrates the length "L" as being somewhat greater than the thickness "d" of the base 28 of the body tip portion, this is not essential. Persons skilled in the art can easily visualize techniques that will permit other dimensional relationships.

Although in Figure 2 bore 34 is shown as a straight cylindrical portion, ven this is not absolutely essential. Th key feature is that bore 34 provides the desired regulation of flow rate of liquid contents 18 from the bottle 10 therethrough. Actually, as a matter of convenience in manufacturing, insert element 32 may be merely a small length of a uniform cylindrical tubing having an internal bore "x" and cut to a suitable length "L". Known techniques for locating a core may be utilized, especially since the outer dimension of insert element 32 is bound to be larger than that of an otherwise necessary core wire having an outer diameter comparable to "x". The details of how the bottle tip portion is molded around insert element 32 are not critical to an appreciation of the advantages of the present invention.

Given a bottle molded with insert element 32 in place per Figure 2, a user must unthread or otherwise detach a protective cap normally attachable to shoulder portion 12, tip the bottle over so that tip end 16 is lowermost, per Figure 1, and then very gently squeeze the body of the bottle to eject through internal bore 34 of insert element 32 a regulated flow of the liquid contents 18 of the bottle. Because of surface tension effects, and because of the conjoint effect of the small bore 34 of small diameter "x" and a preselected length "L", the flow of liquid through the insert element 34 is potentially kept slow enough to cause the liquid to fill up the frustro-conical space defined by surface 26. Eventually, enough liquid having passed through bore 34, liquid will enter the recessed end portion defined by surface 30 and form a liquid bulge thereat. Upon further liquid being ejected from the bottle, a drop determined in size by the diameter "D" and the depth "d" of recess 30 will form as drop 20, eventually neck at 22, and be released as the drop of predetermined size, i.e., at least within an acceptable range of diameter size.

Because bore 34 presents a flow impedance of known magnitude, which is selected with attention paid to the viscosity and other relevant parameters pertaining to the liquid contents 18, there is intentional avoidance of either an uncontrolled squirting of the liquid or a rapid succession of drops from the bottle. In other words, the present invention provides a very definite, inexpensive and easy-to-manufacture structure to controllably dispense a liquid in individual drops within a predetermined size range.

A distinct advantage of the structure according to the preferred embodiment is that different bottles all having the same general shape and size may be utilized to contain and dispense different liquid contents having different viscosities and flow characteristics, simply by selecting for inclusion therein different internal diameters "x" and/or bore lengths "L" of insert elements having the same external diameter so that they can be molded utilizing the same equipment. Assume that there ar two bottles having the same int rnal size and external shape, to be used to dispense two different

liquid contents which must be released in drops of different size or, even if the drops are to be of the same size, the liquids have different viscosities. One simple solution would be to have one or more separately produced tip elements that can be integrated with any individual bottle body in known manner, such a tip element typically being calibrated to provide the desired flow of a selected fluid. Such a tip portion would have essentially the same geometry of structure as that of the delivery end portion of the bottle of Figs. 1 and 2.

The manufacturer need select merely the right internally sized insert 32 while using exactly the same molding equipment otherwise. Conventional techniques would require the provision of different core wires that may differ only slightly in external diameter and yet may each be subject to breakage and consequent problems as adverted to earlier. The combination of the insert element 32 and otherwise conventional bottle tip portion 14, according to this invention, enables a wide range of deliveries, for different types of liquids, to be realized merely by changing insert elements that have essentially the same external shape and size.

Development work on prototype structures suggests that an internal bore diameter "x" within the range 130-150 microns is particularly useful for bottles containing liquids not very different in viscosity from water, e.g., eye drop solutions and the like. Actually, if emulsions for more viscous liquids are to be utilized, e.g., for dispensing a hardener chemical for mixing with an epoxy resin, or a concentrated dye for formulating a particular shade of color by mixing various liquid ingredients, or the like, persons skilled in the art will naturally select the internal dimensions of insert element 32 accordingly.

In this disclosure, there are shown and described only the preferred embodiments of the invention, but, as aforementioned, it is to be understood that the invention is capable of use in various other combinations and environments and is also capable of changes and modifications within the scope of the inventive concept as expressed herein.

Claims

1. A bottle for controllably dispensing liquid contents therefrom as drops that are delivered within a predetermined size range, comprising:
a delivery tip portion, formed internally as an elongate frustro-conical outwardly opening passage having a wide end for forming individual liquid drops thereat and a narrow end for receiving a regulated flow of liquid from the bottle; and
a liquid flow regulating insert element having an internal bore of predetermined cross-sectional area and length, said insert element being located at said narrow end of said tip portion to regulate flow of the liquid from the bottle into said tip portion.

2. A bottle according to claim 1, wherein:
said delivery tip portion is formed to have an annular recess of predetermined depth and a larger transverse cross-sectional area than the wide end of said passage and communicating therewith, whereby individual liquid drops form at said recess for controllable separation therefrom when within said predetermined size range.

3. A bottle according to claim 1, wherein:
said insert element has a generally cylindrical form with an outer cylindrical surface integrable with said delivery tip during formation thereof.

4. A bottle according to claim 3, wherein:
said delivery tip portion is formed to sealingly attach to a sealing cap to thereby seal any liquid contained in said passage and said bottle contents.

5. A bottle according to claim 4, wherein:
said insert element comprises a first plastics material and said bottle is formed of a second plastics material moldable therearound for said integration therewith.

6. A bottle according to claim 5, wherein:
said second material is a thermoplastic material.

7. A bottle according to claim 1, wherein:
said insert element internal bore is in the range 130-150 microns.

8. A bottle according to claim 5, wherein:
said insert element internal bore is in the range 130-150 microns.

9. A tip element attachable to a container body such as a plastic bottle for controllably dispensing liquid contents therefrom as drops that are delivered within a predetermined size range, comprising:
a delivery tip portion, formed internally as an elongate frustro-conical outwardly opening passage having a wide end for forming individual liquid drops thereat and a narrow end for receiving a regulated flow of liquid from the bottle; and
a liquid flow regulating insert element having an internal bore of predetermined cross-sectional area and length, said insert element being located at said narrow end of said tip portion to regulate flow of the liquid from the bottle into said tip portion.

10. A tip element according to claim 9, wherein:
said delivery tip portion is formed to have an annular recess of predetermined depth and a larger transverse cross-sectional area than the wide end of said passage and communicating therewith, whereby individual liquid drops form at said recess for controllable separation therefrom when within said predetermined size range.

11. A tip element according to claim 9,

wherein:
said insert elem nt has a generally cylindrical form with an outer cylindrical surface integrable with said delivery tip during formation thereof.

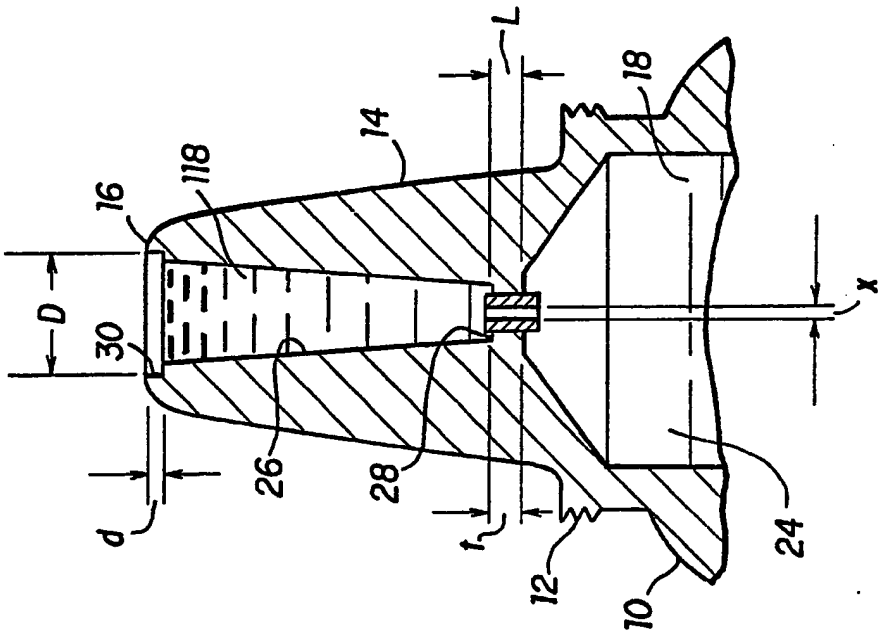

FIG. 2

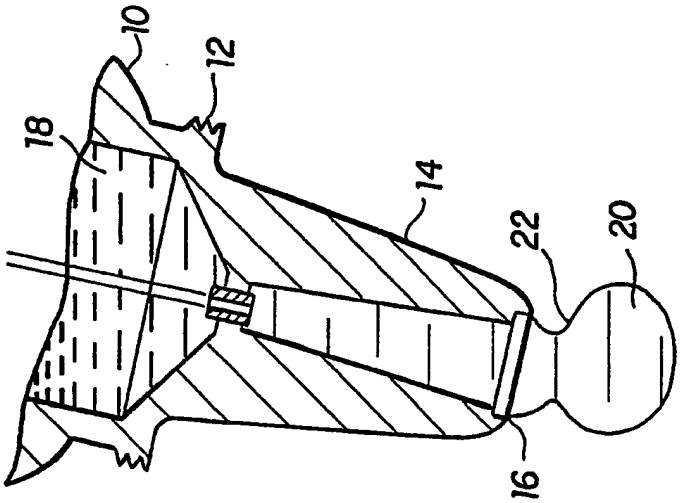

FIG. 1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 20 2150

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
D,A	US-A-3 276 639 (J. F. LANCASTER) * column 4, lines 41-75; figures 3,4 *	1,9	B 65 D 1/08 B 65 D 47/08 B 01 L 3/02
D,A	US-A-3 276 847 (A. A. DUFF) * column 6, line 56 - column 7, line 23; figures 9,10 *	1,9	
A	DE-C- 825 501 (P. FREIHERR VON PECHMANN) * page 2, lines 67-94; figure *	1,2,9, 10	
A	US-A-2 188 802 (L. S. BECKETT) * page 1, right column, lines 13-19,24-32; figure 4 *	1,3,4,9 ,11	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B 65 D
B 01 L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	21-11-1989	SPETTEL J D M L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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